Variable Stars in the Local Group
ASP Conference Series, Vol. 2nn, 2004
D.W. Kurtz & Karen Pollard, eds.

AGB stars in the Magellanic Clouds & in other members of the Local Group

Maria–Rosa L. Cioni
European Southern Observatory, Karl–Schwarschild–Str. 2, D–85748 Garching bei Muenchen, Germany

Abstract. Results obtained in the Magellanic Clouds using the latest near–IR DENIS survey are briefly revised. This sets the base to a similar study of AGB stars in other galaxies in the Local Group and in particular in NGC6822.

1. Introduction

There are two main advantages of studying asymptotic giant branch (AGB) stars in the galaxies of the Local Group (LG). First that we are able using the current instrumentation to resolve their stellar content and second that these stars can be considered to be approximately all at the same distance. Recent studies of AGB stars in the Magellanic Clouds allowed us to gain insight into the near–infrared (near–IR) stellar content of the galaxies, their surface distribution and the ratio between carbon–rich (C–rich) and oxygen–rich (O–rich, M–type) AGB stars easily statistically distinguished in the colour–magnitude diagram (CMD, $J-K_S$, K_S). More recent near–IR observations of other galaxies in the Local Group have been analyzed to tell us similar informations.

2. Results on the Magellanic Clouds

Among the latest near–IR instruments DENIS and 2MASS have released a large amount of data on AGB stars in the Magellanic Clouds. In particular in the DENIS catalogue towards the Magellanic Clouds (DCMC – Cioni et al. 2000a) there are 32800 AGB stars in the Large Magellanic Cloud (LMC) and 7650 in the Small Magellanic Cloud (SMC), of which 7570 and 1640 are C–rich. Blanco et al. (1983) estimated about 11000 and 2900 C–rich stars in the LMC and SMC, respectively. Accounting for about 10% misclassification among the M0–1 stars below the tip of the red giant branch (TRGB) which are missed by our selection criteria based on the near–IR colour–magnitude diagram (CMD), we detect most of the AGB stars in both Galaxies. Infact we detect about the same C stars found by Kontizas et al. (2001) in the LMC (7750) and those 1707 found by Rebeirot et al. (1983) in the SMC.

AGB stars are easily distinguished in the CMD ($I-J$, I) as the plume of objects above the TRGB redder of a given line that discriminates between the younger and older populations (Cioni et al. 2000b). These AGB stars distribute smoothly over the surface of the Clouds in contrast with the bar–like and patchy

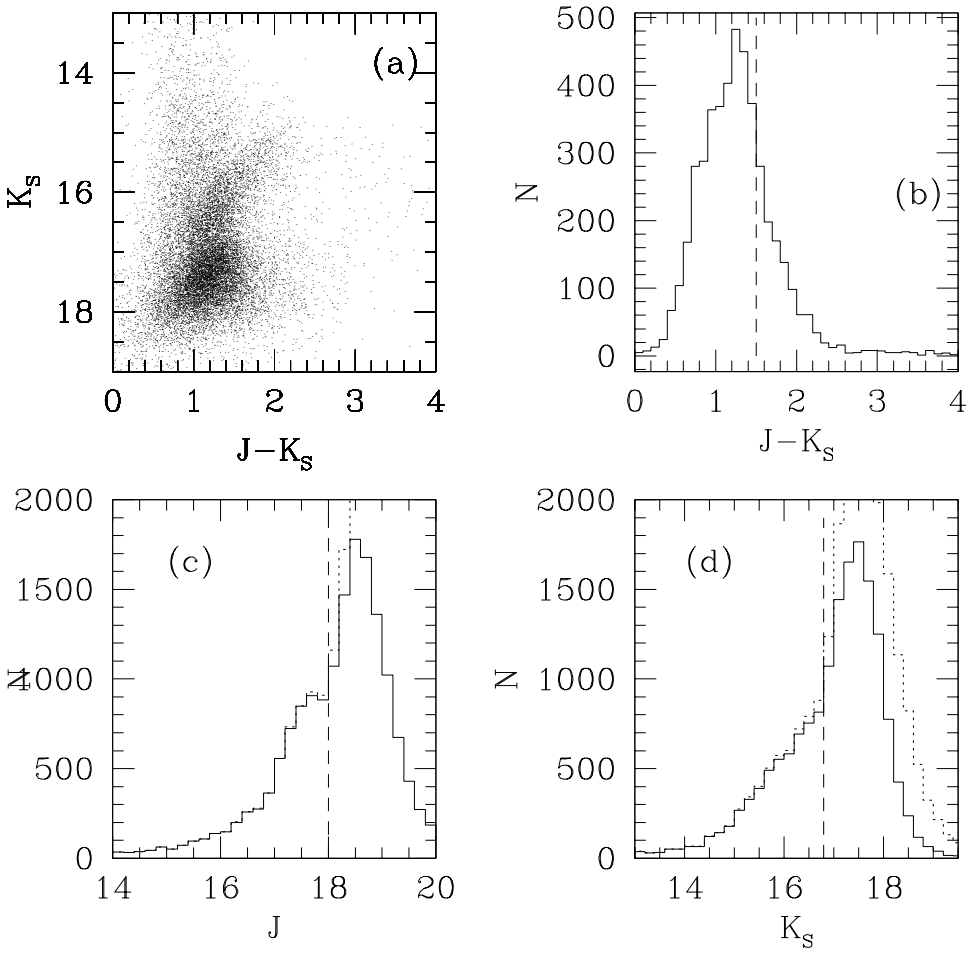

Figure 1. Colour–magnitude diagram and histogram in colour and magnitudes for the sources observed towards NGC6822.

distribution of the younger stars. In the CMD ($J - K_S$, K_S) C–rich AGB stars occupy a red branch compared to the location of O–rich stars. The distribution of the ratio between C–rich and O–rich (C/M ratio) AGB stars outlines in the LMC a ring–like structure of increasing values (Cioni & Habing 2003). Because the C/M ratio is a strong indicator of metallicity the first global evidence that there is a radial metallicity gradient in the LMC was found. The ratio is patchy and irregularly distributed in the SMC. By fitting the distribution of points (Log(C/M) versus [Fe/H]) in other galaxies of the LG a metallicity spread of about 0.75 dex within each Cloud was derived. The larger uncertainty remains in the calibration and scatter of this relation.

3. Results in other Local Group galaxies

Based on the results obtained in the Magellanic Clouds I started in collaboration with Habing a near–infrared campaign from the La Palma observatory to mosaic other galaxies of the LG in I, J and K_S. The goal is to find, study and compare the AGB stellar population.

Fig.1 shows: the ($J - K_S$, K_S) diagram for all the sources detected within an area of $20' \times 20'$ centered on NGC6822 (a), the histogram of the $J - K_S$ colour at about 0.3 mag above the TRGB where the dashed line discriminates between O–rich and C–rich AGB stars (b), and the histograms of J (c) and K_S (d) where the dashed line indicates the approximate location of the TRGB. In NGC6822 we detect about 1339 C stars, approximately 400 more than Letarte et al. (2002), and 2774 M stars. The distribution of the whole AGB population is shown in Fig.2 while Fig.3 shows the distribution of the C/M ratio. Using the same relation discussed in Sect.2 we derive that the gray scale and the contours span a range of 1.65 dex in [Fe/H]. Contrary to Nowotny et al. (2003) we do detect regions with a different C/M ratio. Note that in the K_S band the differential reddening is negligible and that foreground stars have been removed. The striking difference between the two figures indicates the potential of the C/M ratio to study the chemical history of galaxies.

Similar figures, though with less statistics have been obtained for NGC147 and NGC185. Observations of Draco have just been reduced and unfortunately the observations of LeoA, LeoI and LeoII took place during variable sky conditions which considerably affect the quality of the resulting CMDs.

In the Southern Hemisphere the central region of a few galaxies has been observed using SOFI at the NTT in the near–IR wave bands by Tolstoy back in 1998. The CMDs of DDO210, Fornax, SagDIG and Pegasus show clear red giant branches reaching in Fornax the red clump. These galaxies are not rich in AGB stars especially of C type except Pegasus that shows a plum of objects with quite red $J - K_S$ colours. These relatively deep data are probably suitable to derive the metallicity and the age of the observed region (about $5' \times 5'$) from the slope and colour of the RGB as in Davidge (2003). New observations of these and other galaxies visible from the Southern Hemisphere took place at the end of July 2003 in collaboration also with Reijkuba.

The wealth of near–IR data on galaxies in the Local Group either than the Magellanic Clouds will definitely benefit from the latest theoretical results by Marigo et al. (2003). The authors were able to successfully model the red tail

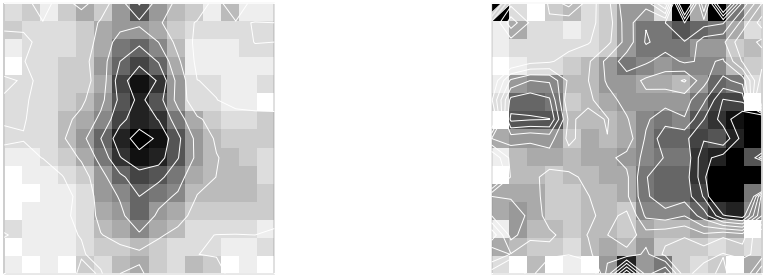

Figure 2. Spatial distribution of AGB stars (left) and C/M ratio (right) in NGC6822.

of C stars producing a synthetic (K_S, $J-K_S$) diagram in very good agreement with the observational data. The key ingredient is to assume an opacity that in cool stars varies with the chemical composition in addition to the assumption of a given pulsation mode (the first overtone for C stars).

4. Conclusions

Large scale informations on AGB stars in the Magellanic Clouds, NGC6822, NGC147 and NGC185 have been discussed: their location in the near–IR CMD, their spatial distribution and that of the C/M ratio. The latter is an important abundance indicator, especially for those systems too far away to measure abundances with other tracers. In the near future we will complete the reduction of complementary I–band measurements, try to complete the observations of some targets not yet fully mosaiced and to continue a monitoring program (in the I–band) that will provide us with an indication about the variability of the target stars. Ultimately we count on publishing homogeneous catalogues of AGB variables that will be useful to the whole community to perform stellar population studies in these relatively nearby galaxies.

References

Blanco V.M., McCarthy M.F., 1983, AJ 88, 1442
Cioni M.-R.L., Habing H.J., 2003, A&A 402, 133
Cioni M.-R.L., Habing H.J., Israel F.P., 2000b, A&A 358, L9
Cioni M.-R.L., Loup C., Habing H.J., et al., 2000a, A&A 144, 235
Davidge T.J., 2003, AJ 125, 3046
Kontizas E., Dapergolas A., Morgan D.H., et al., 2001, A&A 369, 932
Letarte B., Demers S., Battinelli P., et al., 2002, AJ 123, 832
Marigo P., Girardi L., Chiosi C., 2003, A&A 403 225
Nowotny W., Kerschbaum F., Olofsson H., et al., 2003, 403, 93
Rebeirot E., Martin N., Prevot L., et al., 1983, A&AS 53, 255